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(54) ELECTRICAL CONTACT

(71) SQUARE D. COMPANY

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(72) FRANK SIEBER BRUGNER JR.

(74) SW

(56) US 4056365

US 2490214

US 4095977

(57) Claim

1. A process of forming an electric contact for electrical power applications from a first starting material selected from a group essentially consisting of a first metal in powder form and reducible compounds of the first metal in powder form both having a selected maximum particle size, and with a second starting material selected from a group essentially consisting of a second metal in powder form, reducible compounds of the second metal in powder form, and mixtures of the second metal and reducible compounds of the second metal in powder form all having a selected maximum particle size with said second metal and compounds of the second metal selected to be more readily oxidizable than the first metal and compounds of the first metal under similar environmental conditions and added in an amount from a minimum effective amount up to the maximum limit of solubility of the second metal in the first metal by mixing the first and second starting materials together to obtain a mixture

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having a substantially even dispersion of the first and second starting materials, by heating the mixture in a reducing atmosphere at a temperature below the melting temperature of the alloy of the first and second metals in the proportions present to alloy the first and second metals in a powder form and sieving the alloyed mixture to produce a selected maximum particle size; heating the sieved mixture in an oxidizing atmosphere at a temperature and under conditions selected to substantially completely oxidize the second metal with said temperature below the melting temperature of the alloy of the first and second metals in the proportions present to thereby maintain the mixture and provide an oxidized mixture in a powder form and sieving the oxidized mixture to produce a selected maximum particle size, said process comprising adding to the oxidized mixture at a selected time during the process as solution containing lithium metal in the form of lithium carbonate particles and evaporating the solution to provide a powdered material with the lithium carbonate particles uniformly distributed throughout the powdered material, forming a compact of the powdered material to provide an electrical contact having a desired shape, size and density, and sintering the compact for a predetermined time at a temperature less than the decomposition temperature of the lithium carbonate to provide a sintered electrical contact.

lithium carbonate in an amount of 0.001 to 0.01 weight percent.

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OWNED

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REGULATION 9

FORM 1

64605/80

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-1979

APPLICATION FOR A STANDARD PATENT

We, SQUARE D. COMPANY, a Company organised under the laws of the State of Michigan, United States of America, of Executive Plaza, Palatine, Ill. 60067, United States of America, hereby apply for the grant of a standard patent for an invention entitled:-

"SILVER, CADMIUM OXIDE, LITHIUM CARBONATE
CONTACT MATERIAL AND METHOD OF MAKING THE
MATERIAL"

which is described in the accompanying Complete Specification.

Our address for service is:-

SHELSTON WATERS,

55 Clarence Street,

SYDNEY, N.S.W. 2000.

DATED this 5th day of November, 1980.

SQUARE D. COMPANY

Robert G. Shelston

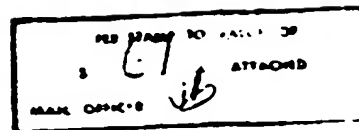
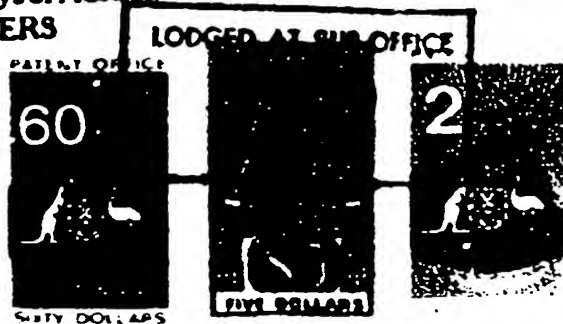
Fellow Institute of Patent Attorneys of Australia
of SHELSTON WATERS

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MS



(NON-CONVENTION—Company)

FORM 7—REGULATION 12 (1)

64095/80

COMMONWEALTH OF AUSTRALIA
PATENTS ACT, 1952-1969

DECLARATION IN SUPPORT OF AN APPLICATION FOR A PATENT.

(1) Here insert (in full) Name of Company

In support of the Application made by (a)

SQUARE D COMPANY

(hereinafter referred to as "Applicant") for a patent for an invention entitled:

(2) Here insert Title of invention

"SILVER, CADMIUM OXIDE, LITHIUM CARBONATE CONTACT MATERIAL AND METHOD OF MAKING THE MATERIAL"

(3) Here insert Full Name and Address of Company Official authorised to make declaration

I, (a)
W. A. RICHARDS
PARLIAMENT
THORVERTON
EXETER EX5 5LA ENGLAND

do solemnly and sincerely declare as follows:

1. I am authorised by Applicant to make this declaration on its behalf.

2. (a) Frank Sieber BRUGNER JR.

of 11415 N. Oriole Lane, 20N, Mequon, Wis. 53092 USA

(4) Here insert (in full) Name and Address of Actual Inventor(s)

is/are

the actual inventor(s) of the invention and the facts upon which Applicant is entitled to make the Application are as follows:

Applicant is the Assignee of the said Inventor(s).

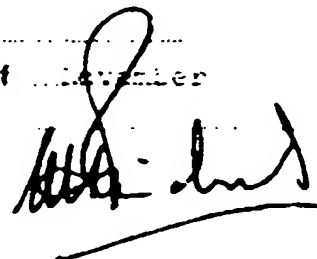
Declared at

this 22nd

day of November

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(5) Personal Signature of Declarant (a) (no seal, witness or legalization)



TO THE COMMISSIONER OF PATENTS.

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FORM 10

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-69

COMPLETE SPECIFICATION

FOR OFFICE USE:

Class

Int. Class

Application Number:

Lodged:

64095/80

Complete Specification Lodged:

Accepted:

Published:

Priority:

Related Art:

This document contains the
amendments made under
Section 29

and is correct for printing.

Name of Applicant: SQUARE D. COMPANY

Address of Applicant: EXECUTIVE PLAZA, PALATINE, ILL. 60067, UNITED STATES OF AMERICA

Actual Inventor: FRANK SIEBER BRUGNER JR.

55

Address for Service: Shelston Waters, 2028 Clarence Street, Sydney

Complete Specification for the invention entitled: "SILVER, CADMIUM OXIDE, LITHIUM CARBONATE CONTACT MATERIAL AND METHOD OF MAKING THE MATERIAL"

The following statement is a full description of this invention, including the best method of performing it known to me/us:—

1 This invention relates to electrical contacts for
2 making and breaking low to medium power circuits and more
3 particularly to the metallurgical composition and the
4 method of making such contacts.

5 It is well known in the prior art to make electrical
6 contacts from a conductive material and an added material
7 that provides embrittlement qualities to the contact.
8 Typically, silver and cadmium oxide mixtures are used for
9 most medium and low alternating electrical power switching
10 applications. Recently such electrical contacts have been
11 improved, particularly with respect to the erosion rate, by
12 the addition of a third material having a low electronic
13 work function, such as lithium, preferably in the form of
14 lithium oxide. The material and the method of making the
15 material so that the lithium oxide is uniformly distributed
16 throughout the material is disclosed and claimed in U.S.
17 patents Nos. 4,011,053 and 4,011,052, which issued on
18 March 8, 1977 and are assigned by the patentee T. A. Davies
19 to the assignee of the present invention. A more recent
20 development in the art of making silver, cadmium oxide and
21 lithium oxide contact materials is disclosed in United
22 States Patent No. 4,095,977 which issued on June 20, 1978
23 and is assigned by the patentee F. S. Brugner to the assignee
24 of the present invention. The Brugner patent, as combined
25 with the Davies patents, discloses that if a minute critical
26 amount of lithium oxide is present in the silver cadmium
27 oxide contact material and is uniformly distributed
28 therein, an unexpected dramatic increase in the contact

1 life is achieved.

2 When the teachings of Davies and Brugner are followed,
3 a contact material is produced that has vastly superior
4 erosion resistance characteristics and these
5 characteristics are produced by adding an unexpected
6 small amount of low electronic function material to
7 achieve the maximum benefit. It has been thus estab-
8 lished that maximum resistance to erosion of a contact
9 can be obtained by carefully selecting the material and
10 the percentage of low electronic work function material in
11 the form of an oxide of the material, which is uniformly
12 distributed in a silver cadmium oxide contact.

13 Silver cadmium oxide powdered metal contacts usually
14 are provided with a backing of fine metallic silver which
15 is attached to a highly conductive metal support, such as
16 copper, by a suitable method such as silver-soldering method
17 When the contacts are produced according to the methods
18 heretofore known, as exemplified by the Davies patents, a
19 solution containing a compound that is reducible to lithium
20 oxide is usually introduced into the powdered contact
21 material to form a slurry which is subsequently treated to
22 change the lithium compound to lithium oxide which is
23 precipitated upon the particles of silver cadmium oxide.
24 In the event that the step of reducing the compound of
25 lithium to lithium oxide is not incorporated into the
26 process, or the reduction to lithium oxide is incomplete,
27 when the fine silver powdered backing is placed upon the
28 material and the contacts are sintered to form the

individual contacts, blisters are formed due to decomposition of the reducible lithium compound and subsequent gas entrapment forms between the fine silver backing and the contact material, as illustrated in the drawings.

It is an object of this invention to overcome the formation of blisters when the contacts are sintered.

It is a further object of this invention to eliminate the step of producing the lithium oxide compound in the slurry.

Both of these advantages are obtained by the practice of this invention.

When the contacts are formed according to the present invention, lithium is introduced into the contact material in the form of lithium carbonate which is dissolved in a suitable solvent, e.g., water. The silver cadmium oxide powdered particles are mixed in the solution to form a slurry which is subsequently dried to eliminate the step in the prior art process which requires the lithium oxide compound to be produced by the formation of lithium oxide from some other lithium compound before the fine silver backing is applied. When the dried silver cadmium oxide powder containing lithium carbonate powder is compressed and the silver powder backing placed thereon, the sintering of the contact will not cause entrapment of gas and blisters to appear between the silver layer and the contact material so that the silver layer remains substantially flat, as shown in the drawings, and an excellent bond may be achieved between the contact material and the copper backing when it is attached as previously described.

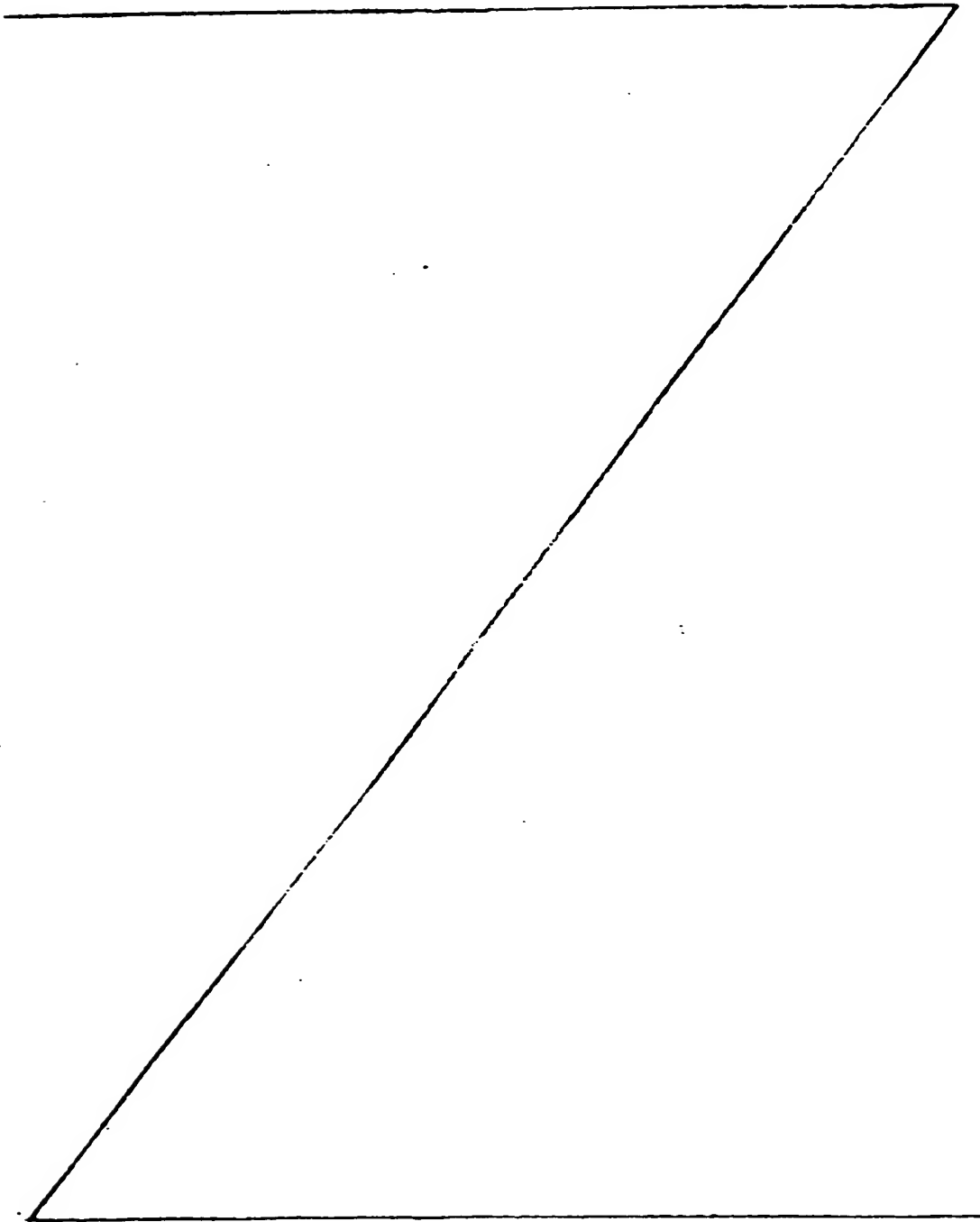
The objects and other advantages of this invention



will appear from the following description.

Fig.1 is a drawing of a plan photographic view of a contact formed of pure silver.

Fig.2 is a drawing of a plan photographic view of a contact formed of pure silver with 300 parts per million of



1 lithium added in the form of lithium nitrate to the
2 silver powder.

3 Fig. 3 is a drawing of a plan photographic view of a
4 contact formed of pure silver with 300 parts per million
5 of lithium added in the form of lithium carbonate to the
6 silver powder.

7 In each of the specimens shown in the drawings the
8 silver powder is of the type known as "Fine Silver Powder
9 Type 0" which may be obtained from the Metz
10 Metallurgical Corporation located at Plainfield,
11 New Jersey, U.S.A. As specified, the Type 0 fine silver
12 powder has an apparent density of 6.8 grams per cubic inch
13 and 100% of the powder will pass through a 200 mesh screen.

14 In accordance with this invention, material for use in
15 making electrical contacts is produced by standard
16 metallurgical or other suitable techniques. Since it is
17 known that silver is a preferred metal and cadmium oxide
18 is a preferred high percentage additive, materials
19 selected for tests comprised 85% silver and 15% cadmium
20 oxide by weight. This material is known to produce good
21 contacts and was produced with a powder process. While
22 any process using the same basic constituents would produce
23 improved results, the prior art indicates that material
24 made by a powder process using an internal oxidizing
25 procedure would produce the greatest improvement.

26 To produce contacts according to the invention, a
27 powder is made by mixing a first and second starting
28 material in the desired proportions. The first starting

1 material is silver powder as above described. The second
2 starting material is cadmium oxide powder having particles
3 in the size range of 0.01 to 2 microns in diameter. The
4 two powders are dry tumble mixed in a drum and the finally
5 mixed powders are sieved through a 40 micron screen.

6 The sieved powder is heated in a highly reducing
7 atmosphere of hydrogen to convert the cadmium oxide to
8 cadmium by placing it in a furnace at a temperature of
9 about 200 to 700°C. The powder is spread to a depth of
10 about one centimeter. The temperature is kept below the
11 melting temperature of the resulting alloy that would be
12 produced by the proportion of silver and cadmium present
13 to prevent forming of a melt and alloying occurs as the
14 cadmium dissolves or diffuses into the silver particles.

15 The resulting alloyed material is mechanically broken
16 down and sieved through a 500 micron screen to produce an
17 alloy in a powder or particle form. The sieved alloy
18 powder is then heated in an oxidizing atmosphere at a tem-
19 perature low enough to prevent the forming of a melt and
20 high enough to assure complete internal oxidation. The
21 oxidized alloy material is then sieved to a degree of
22 fineness appropriate for making contacts as known.

23 A third starting material, which preferably is a
24 lithium carbonate compound and is known as a low work
25 function metal material, is dissolved in a suitable solvent,
26 e.g., water, to form a solution. The solution is then
27 mixed with the oxidized alloy to form a slurry.
28 Percentages of the materials in the slurry are selected

1 to reach the desired end result and the slurry is then dried
2 to produce an internally oxidized silver cadmium alloy
3 powder with small crystals of the lithium carbonate com-
4 pound of the low work function material formed on the sur-
5 face of the powder particles. The dry powder mixture is
6 then sieved through a suitably sized screen to break up any
7 large cakes of material formed during drying to produce a
8 powdered material having particle sizes suitable for making
9 contacts.

10 The contacts are processed by typical metallurgical
11 techniques involving compressing the material to form a com-
12 pact body, sintering the body at a temperature of approxi-
13 mately 900°C., which is less than the dissolution tempera-
14 ture of lithium carbonate, and coining the sintered body
15 for the final shape and size required for the contacts.

16 Contacts fabricated to contain lithium carbonate
17 according to the process of the present invention exhibited
18 substantially the same resistance to erosion as the contacts
19 containing lithium oxide as disclosed in the Brugner patent
20 when the amount of lithium additive in the two different
21 contacts were substantially equal. However, to form the
22 lithium oxide as disclosed in the Brugner patent required
23 the additional step wherein the lithium oxide was formed
24 from a reduced lithium compound. This step has been
25 eliminated in the method according to the present invention
26 without reducing the effectiveness of the lithium in the
27 final contact product.

28 It has been previously indicated that the lithium metal

is a low electronic work function material. The theory of operation of the low electronic work function material in the performance of the contact material is fully disclosed in the Brugner patent and therefore is incorporated herein by reference and further explanation of the operation of the material is not believed necessary as it is now well known to those skilled in the art. That patent, which is known as the Brugner patent, discloses that if a minute critical amount of lithium oxide, as for instance from .01 to .001 weight
10 percent lithium and preferably .6 % is present in the silver cadmium oxide contact material and is uniformly distributed therein, an unexpected dramatic increase in the contact life is achieved.

Thus, when the teachings of Davies and Brugner are followed, the contact material produced has vastly superior erosion characteristics. These erosion resistant characteristics are provided by the addition of an unexpected small amount of a low electronic function material to achieve the maximum benefit. It has been thus established according to the present
20 invention that maximum resistance to erosion is obtained by carefully selecting the proper percentage of low electronic work function material in a stable lithium carbonate compound form that does not require a chemical modification to a lithium oxide form to achieve the desired end result; that is, forming an electrical contact that is highly resistant to electrical erosion.

The following example illustrates the manner in which the method according to the present invention may be carried out as applied to the manufacture of a silver-



1 cadmium-oxide contact material including lithium carbonate
2 with the cadmium oxide and the lithium carbonate present in
3 precise amounts and uniformly distributed throughout the
4 contact material. Initially, 200 grams of a silver-
5 cadmium oxide powder containing 15% cadmium oxide and 85%
6 silver as formed by the reduction and subsequent oxidation
7 process as disclosed in the Davies and Brugner patents
8 supra was weighed into a glass beaker and 0.058 grams of
9 lithium carbonate (Li_2CO_3) powder was weighed on a stain-
10 less steel dish on a microbalance. The stainless steel
11 dish and lithium carbonate powder was then placed into a
12 clean Teflon beaker and rinsed with redistilled water for
13 about one minute to remove all extraneous matter and con-
14 taminants. Redistilled water was then introduced in the
15 beaker to a level of approximately 1/4 inch above the
16 bottom of the beaker. The beaker and its contents was
17 placed in a freezing environment for a short time (approx-
18 imately 15 minutes) to increase the solubility of lithium
19 carbonate in the water. The beaker was removed from its
20 freezing atmosphere and the solution was mixed to dissolve
21 the Li_2CO_3 in water which solution was added to the pre-
22 viously formed Ag-CdO powder in the glass beaker. The
23 Teflon beaker was rinsed with redistilled water into the
24 glass beaker and additional redistilled water was added to
25 the glass beaker to form a slurry of the contents within
26 the glass beaker. The slurry was thoroughly mixed and the
27 glass beaker was covered with a watch glass and placed in a
28 60°C oven for eight hours to dry the contents in the beaker.

1 After the powdered material was thoroughly dry, any lumps
2 of material which may have been formed during the process
3 were broken up and the material was passed through a 100
4 mesh screen for processing into electrical contacts
5 according to well known metallurgical techniques as
6 described, supra.

7 The photographs, of which Figs. 1-3 are drawings,
8 clearly demonstrate the marked differences when lithium
9 nitrate and lithium carbonate is added to a fine silver
10 powder. The photographs showed contacts not containing
11 cadmium oxide and each was taken after Metz Type O fine
12 silver powder was compressed under 30,000 psi and sintered
13 for one hour at 920°C. Each of the photographs was taken
14 with a 65 mm lens with an aperture opening of 6 to provide
15 a magnification of 5 times the size of the contact photo-
16 graphed. The contact in Fig. 1, which was formed of a fine
17 silver powder, was photographically exposed for 1/8 of a
18 second. The contacts in the photographs from which Figs.
19 2 and 3 were drawn each have 300 ppm Li added thereto and
20 were photographically exposed for 1/30 of a second.

21 Lithium additive in Fig. 2 is lithium nitrate (Li NO_3) and
22 the additive in Fig. 3 is lithium carbonate (Li_2CO_3). The
23 300 ppm which was added for demonstration purposes is far
24 greater than the amounts recommended in the Brugner patent,
25 supra.

26 As shown by the photographs, when contact material
27 containing Li NO_3 having a fine silver powder backing is
28 compressed and sintered at a temperature of 920°C or above,

1 which is required to cause proper sintering of the contact
2 material, the temperature will be greater than 600°C which
3 is the decomposition temperature of Li NO_3 and gas blisters
4 will form between the contact material and the sintered
5 silver backing. Note in Fig. 2 the two blisters which were
6 formed by trapped gas as the Li NO_3 decomposed to form Li_2O
7 are particularly prominent. In contrast, when Li_2CO_3 ,
8 which melts at 723°C and decomposes at 1310°C is added to
9 the contact material and the material is compressed and
10 sintered at a temperature of 920°C , the lithium carbonate
11 will melt at 723°C but not decompose and blisters will not
12 form, as illustrated by Fig. 3 which shows the same charac-
13 teristics as illustrated by the contact in Fig. 1 which is
14 made of fine silver without any additives.

15 While certain preferred embodiments of the invention
16 have been specifically disclosed, it is understood that the
17 invention is not limited thereto, as many variations will
18 be readily apparent to those skilled in the art and the
19 invention is to be given its broadest possible interpre-
20 tation within the terms of the following claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A process of forming an electric contact for electrical power applications from a first starting material selected from a group essentially consisting of a first metal in powder form and reducible compounds of the first metal in powder form both having a selected maximum particle size, and with a second starting material selected from a group essentially consisting of a second metal in powder form, reducible compounds of the second metal in powder form, and mixtures of the second metal and reducible compounds of the second metal in powder form all having a selected maximum particle size with said second metal and compounds of the second metal selected to be more readily oxidizable than the first metal and compounds of the first metal under similar environmental conditions and added in an amount from a minimum effective amount up to the maximum limit of solubility of the second metal in the first metal by mixing the first and second starting materials together to obtain a mixture having a substantially even dispersion of the first and second starting materials, by heating the mixture in a reducing atmosphere at a temperature below the melting temperature of the alloy of the first and second metals in the proportions present to alloy the first and second metals in a powder form and sieving the alloyed mixture to produce a selected maximum particle size; heating the sieved mixture in an oxidizing atmosphere at a temperature and under conditions selected to substantially completely oxidize the second metal with said temperature below the melting temperature of the alloy of the first and second metals in the proportions present to thereby maintain the mixture and provide an oxidized mixture in a powder form and sieving the oxidized mixture to produce a

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selected maximum particle size, said process comprising adding to the oxidized mixture at a selected time during the process as solution containing lithium metal in the form of lithium carbonate particles and evaporating the solution to provide a powdered material with the lithium carbonate particles uniformly distributed throughout the powdered material, forming a compact of the powdered material to provide an electrical contact having a desired shape, size and density, and sintering the compact for a predetermined time at a temperature less than the decomposition temperature of the lithium carbonate to provide a sintered electrical contact.

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2. The process as recited in claim 1 wherein a layer of silver powder is added to one side of the compact before the compact is sintered to provide the contact with a silver backing.

3. The process as recited in claim 1 wherein the first metal is silver and the second material is cadmium oxide.

4. The process as recited in claim 1 wherein the first metal is silver, the second material is cadmium oxide, the lithium carbonate is dissolved in a suitable solvent to form a solution, mixing the oxidized mixture in the solution to form a slurry having a selected consistency and to obtain a uniform distribution of a selected proportion of lithium in the powdered material.

5. The process as recited in claim 2 wherein the first metal is silver and the second material is cadmium oxide.

6. A sintered electrical contact for use as switching contacts in power circuits consisting essentially of silver, cadmium and lithium with silver present in a metallic form, the cadmium present as cadmium oxide and the lithium present as



lithium carbonate in an amount of 0.001 to 0.01 weight percent.

6. 7. An electrical contact as recited in claim 6 wherein the cadmium oxide is selected to impart desired embrittlement qualities to the electrical contact and is added from a minimum effective amount up to a maximum equal to the limit of solubility of the cadmium in the silver.

8. An electrical contact as recited in claim 7 wherein the contact consists of approximately 85 weight percent silver, 15 weight percent cadmium oxide and 0.01 to .001 weight percent lithium.

9. An electrical contact as recited in claim 7 wherein the contact consists of approximately 85 weight percent silver, 15 weight percent cadmium oxide and approximately .005 weight percent lithium.

10. An electrical contact as recited in claim 6 wherein the contact consists of approximately 85 weight percent silver, 15 weight percent cadmium oxide and 0.01 to .001 weight percent lithium.

11. An electrical contact as recited in claim 6 wherein the contact consists of approximately 85 weight percent silver, 15 weight percent cadmium oxide and approximately .005 weight percent lithium.

12. The electrical contact as recited in claim 6 wherein the silver, cadmium oxide and lithium carbonate are particles of uniform size and uniformly distributed throughout the contact.

DATED this 17th November 1983

SQUARE D. COMPANY

Attorney: ROBERT C. SHELSTON
Fellow Institute of Patent Attorneys of Australia
of SHELSTON WATERS

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FIG. 1



FIG. 2



FIG. 3

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